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**STUDY TITLE:** Workshop on Hydrological Modeling of Freshwater Discharge from Alaska's Arctic Coast

**REPORT TITLE:** Proceedings of a Workshop on Hydrological Modeling of Freshwater Discharge from Alaska's Arctic Coast

**CONTRACT NUMBER:** 0102CA85294; **TASK ORDER (TO):** 35262

**SPONSORING OCS REGION:** Alaska

**APPLICABLE PLANNING AREA:** Beaufort Sea and Chukchi Sea

**FISCAL YEAR OF PROJECT FUNDING:** 2003

**COMPLETION DATE OF REPORT:** August 2005

**COST:** FY 2003: \$77,844; **CUMULATIVE PROJECT COST:** \$77,844

**PROJECT MANAGER:** Richard Prentki

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**KEY WORDS:** Hydrological cycle, freshwater runoff, digital elevation model (DEM), watershed, land processes, atmospheric downscaling forcing, circulation, landfast ice zone, nearshore Beaufort Sea

#### **BACKGROUND:**

The development of offshore oil exploration and production facilities on the inner shelf of the Beaufort Sea might impact the nearshore biota and inhibit clean up of spilled pollutants. This project (hydrological modeling workshop) was undertaken to bring modelers and observationalists together to discuss strategies for state-of-the-art hydrological modeling north of the Brooks Range. The workshop highlighted approaches to medium-range, regional hydrological modeling that could be applied to the North Slope region, which drains to the nearshore Beaufort and Chukchi seas, affecting seasonal landfast ice, coastal circulation, and water mass properties.

This hydrological modeling workshop is directly related to the MMS framework issue "Modeling studies of environmental, social, economic, or cultural processes related to OCS gas and oil activities in order to improve scientific predictive capabilities." MMS is interested in freshwater runoff because it is important locally in the coastal Beaufort Sea: it enhances breakup of nearshore ice and affects release of spilled oil from landfast ice, water mass properties, and density-driven currents of the nearshore shelf, such as coastal current along Alaska's Arctic coast. Furthermore, changes in timing and amounts of river runoff to the arctic shelves may affect the ocean circulation.

\*P.I.'s affiliation may be different than that listed for Project Manager(s).

**OBJECTIVES:**

The objectives of this workshop were 1) to promote discussion of the following topics:

- Climate variability and its impacts on hydrological cycle in the Arctic
  - Collection and archival of hydrological datasets in Alaska
  - Hydrological modeling approaches on the North Slope
  - Hydrology-related sea ice, oceanography, and geochemistry,
- and 2) to produce recommendations, which are valuable for MMS needs and which may be used as a guideline to arctic hydrological modeling and related research areas.

**DESCRIPTION:**

The workshop had three research themes: 1) Climate and variability and its impacts, 2) Hydrological observations and modeling, and 3) Sea ice, oceanography, and geochemistry. There were 28 participants (23 presentations). Each theme had a rapporteur to chair the discussions and summarize the recommendations at the end of the workshop. The workshop focused on precedents in data processing, hydrological modeling, and field observations: including needs, scientific and economic issues, and possible solutions in this region. The participants included scientists and managers from academic institutions, governmental laboratories, the state and borough, and local communities.

**SIGNIFICANT CONCLUSIONS:**

The workshop made a series of detailed recommendations in the three research themes, and proposed an interdisciplinary (hydrology, meteorology, oceanography, sea ice, and geochemistry) integration/synthesis (I/S) study in the pan-North Slope (and Beaufort-Chukchi Seas) region, an important research platform for oil and gas exploration and development. The proposed I/S in the pan-North Slope region can be linked to IPY 2007–2008. The strategy of this I/S will combine modeling (ice-ocean, hydrological, and downscaling of atmospheric forcing) with field observations (river gauges, meteorological measurements, satellite measurements, etc.).

**STUDY RESULTS:**

Based on the working group recommendations, a concise summary is drawn as follows:

**Theme 1: Climate variability and its impacts**

- 1) Improve the basic data record by establishing observations (temperature, precipitation, wind, etc.) for the following areas, in order of importance: a. The Brooks Range, b. The interior regions of the North Slope, c. The Alaska Beaufort and Chukchi coasts linked to the International Polar Year initiative.
- 2) Climate model data should be downscaled to improve utility for the terrestrial hydrological modeling context.
- 3) Assess general circulation model output for the Alaska region, in terms of a) Internal consistency (i.e., model to model), and b) Accuracy of representation (compared to observational data)
- 4) Establish an Alaska data clearing house. There are observational data sets that do exist; having them at one accessible portal would enhance future research efforts. Given the unique nature of Alaska in the U.S. arctic system, perhaps the National Snow and Ice Data Center (NSIDC) could be approached to add an "Alaska" search term to their data sets.
- 5) Evaluate the potential of satellite-derived data for providing climate fields relevant to hydrological modeling at the North Slope scale. Parameters could include surface and near-surface air temperature, snow water equivalent, or soil moisture content.

**Theme 2: Hydrological Observation and Modeling**

- 1) Development of a fine-resolution (1–5 km) DEM-based hydrological model covering the entire North Slope from the Brooks Range to the coastal region. The scientific objections are to understand i) thermokarst occurrence and potential for increase in sediment and carbon fluxes, ii) Groundwater dynamics, aufeis fields and permafrost distribution.
- 2) Combine different methods (remote sensing, modeling, ground measurements). In addition, an intelligent, physically-based scheme for downscaling coarse meteorology (e.g. European Center for Medium Range Weather Forecasting [ECMWF]) or interpolating station observations in data sparse regions should be developed.
- 3) Reestablish U.S. Geological Survey gages on the North Slope.
- 4) Establish a web site that provides links for data sets.

**Theme 3: Sea Ice, Oceanography, and Geochemistry**

- 1) High-resolution (1–5 km) ocean-sea ice models in the Chukchi-Beaufort Seas should be developed under forcing of freshwater discharge (both point source/rivers and line source) derived from a high-resolution pan-North Slope DEM-based hydrological model. Improve/develop parameterizations of landfast ice in large scale ice-ocean models.
- 2) Coordinated field measurement and modeling studies: parallel efforts to maximize limited resources, use model guidance to choose 'ideal' site for long-term/process studies, such as focused process studies of landfast ice, coastal currents, fronts and density-driven circulation, and measurements of freshwater flux through Bering Strait.
- 3) Determine relative importance of North Slope vs. Mackenzie runoff impact on local ice-ocean dynamics; modeling sensitivity studies of the ocean dynamics response to freshwater inputs and pathways from the North Slope
- 4) Prediction of effects of severe/single storm on coastal erosion, sediment transport, ecosystem variability, impact on humans, and pollutant dispersal, such as storm-induced coastal upwelling, changes in vertical structures of T&S, and mixing.
- 5) Remotely sensed data on surface ocean thermal fronts for model validation/improvements, landfast ice, and multi-year sea ice.

**STUDY PRODUCTS:**

- Wang, J. 2005. Report on Workshop on Hydrological Modeling of Freshwater Discharge from Alaska's Arctic Coast. MMS Information Transfer Meeting, April 2005, Anchorage.
- Wang, J. 2005. Workshop on Hydrological Modeling of Freshwater Discharge from Alaska's Arctic Coast. International Conference on Global Change: Connection to the Arctic (6). Dec. 11–13, 2005. Miraikan, Koto-ku, Tokyo, Japan (poster).

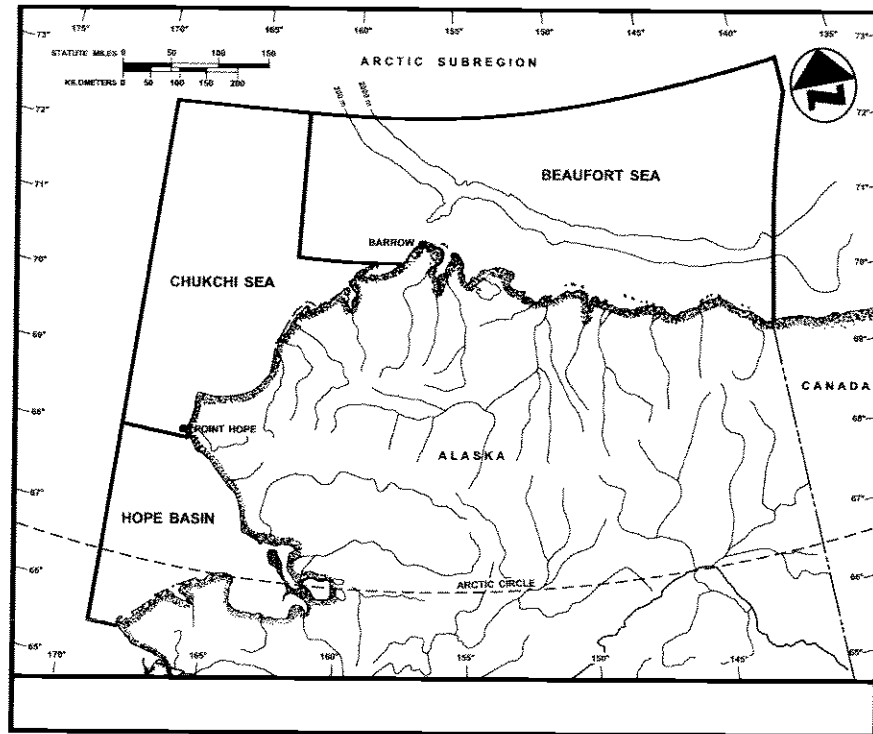


Figure 1. Focus area for Beaufort Sea Nearshore Under-Ice Currents: Science, Analysis, and Logistics.

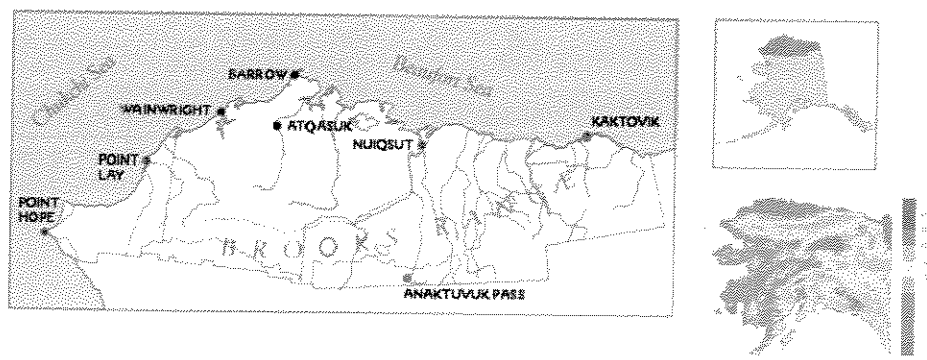


Figure 2. (Left upper) River networks in the North Slope region and outer continental shelf in the Beaufort and Chukchi seas. (Right lower) Terrain distribution based on the ETOPO5 (9.2 km) dataset, a much coarser resolution dataset than the GTOPO30 (1 km). The Brooks Range divides the North Slope watershed from the Yukon River watershed south of the Brooks Range. The Mackenzie River watershed in Canada is not shown.